



NextSTEP Habitat Ground Test

EVA Technology Workshop 2017

October 17, 2017

Bill Othon

NextSTEP Ground Test lead

Exploration Integration and Test Lead/EA53

NextSTEP Hab Overview



NextSTEP Phase 1: 2015-2016

Cislunar habitation concepts that leverage commercialization plans for LEO



LOCKHEED MARTIN



BIGELOW AEROSPACE



ORBITAL ATK



BOEING

FOUR
SIGNIFICANTLY
DIFFERENT
CONCEPTS
RECEIVED

Partners develop required deliverables, including concept descriptions with concept of operations, NextSTEP Phase 2 proposals, and statements of work.

NextSTEP Phase 2: 2016-2018



BIGELOW
AEROSPACE

FIVE GROUND
PROTOTYPES
BY 2018



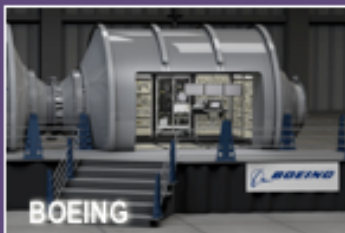
SIERRA NEVADA
CORPORATION



ORBITAL ATK



LOCKHEED
MARTIN



BOEING

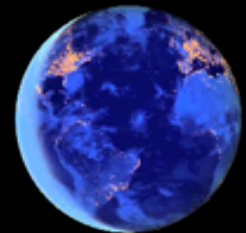
- Partners refine concepts and develop ground prototypes.
- NASA leads standards and common interfaces development.

ONE CONCEPT STUDY



NANORACKS IXION

Initial discussions
with international
partners



Define reference habitat
architecture in preparation
for Phase 3.

Phase 3: 2018+

- Partnership and Acquisition approach, leveraging domestic and international capabilities
- Development of deep space habitation capabilities
- Deliverables: flight unit(s)

NextSTEP Phase 2 Goal



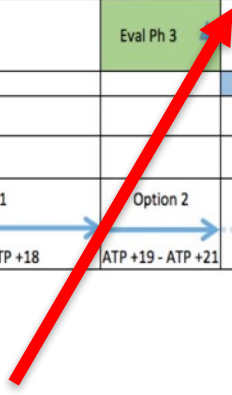
Develop a deep space habitat for ground-based testing by 2018, while simultaneously stimulating commercial habitat development in LEO

- Develop long-duration deep-space habitation capabilities that lead towards a deep-space transit habitat and can be flown on SLS flight(s) (or alternative launch vehicles) starting by the early to Mid 2020s.
- Advance the long duration deep space habitation capability concepts and mature the design and development of the integrated system(s) to achieve a high level of fidelity.
 - Developing prototype deep space habitation capability options to test a full size ground prototype unit(s) by the end of Phase 2 in 2018 to support first flight opportunities in Early to Mid 2020s
- Potential for different capabilities from domestic and international suppliers will require standards and common interfaces for aggregation. NASA led standards working group will be implemented during Phase 2.



Ground Prototype units delivered to NASA for testing and integration of NASA developed habitation systems

- Testing includes form, fit, volumetric, subsystem integration, and interface standards
- May use NASA-developed node/airlock and hab mockups for integration testing with contractor modules
- Ensures consistent test and interface verification approach, allows us to incorporate and test other AES subsystems, facilitates crew training and feedback on human factors, shows stakeholders progress



6 Months of NASA Evaluation

Habitat Ground Testing



NextSTEP Ground Test



- Purpose of NextSTEP Ground Testing
 - Evaluate design concepts for habitation systems, through test
 - Use test to support RAC and DAC analysis
 - Mature requirements for NextSTEP Phase 3
- NextSTEP is a Public/Private Partnership
 - Collaborate with partners, to ensure design ideas are fully explored
 - Allow NASA to make the most of the limited time we have for test
- Identify elements of design that impact integrated performance
 - Packaging
 - Logistics
 - Consumables
 - Interfaces

Goal: Prepare habitat systems for successful
Ground Test execution

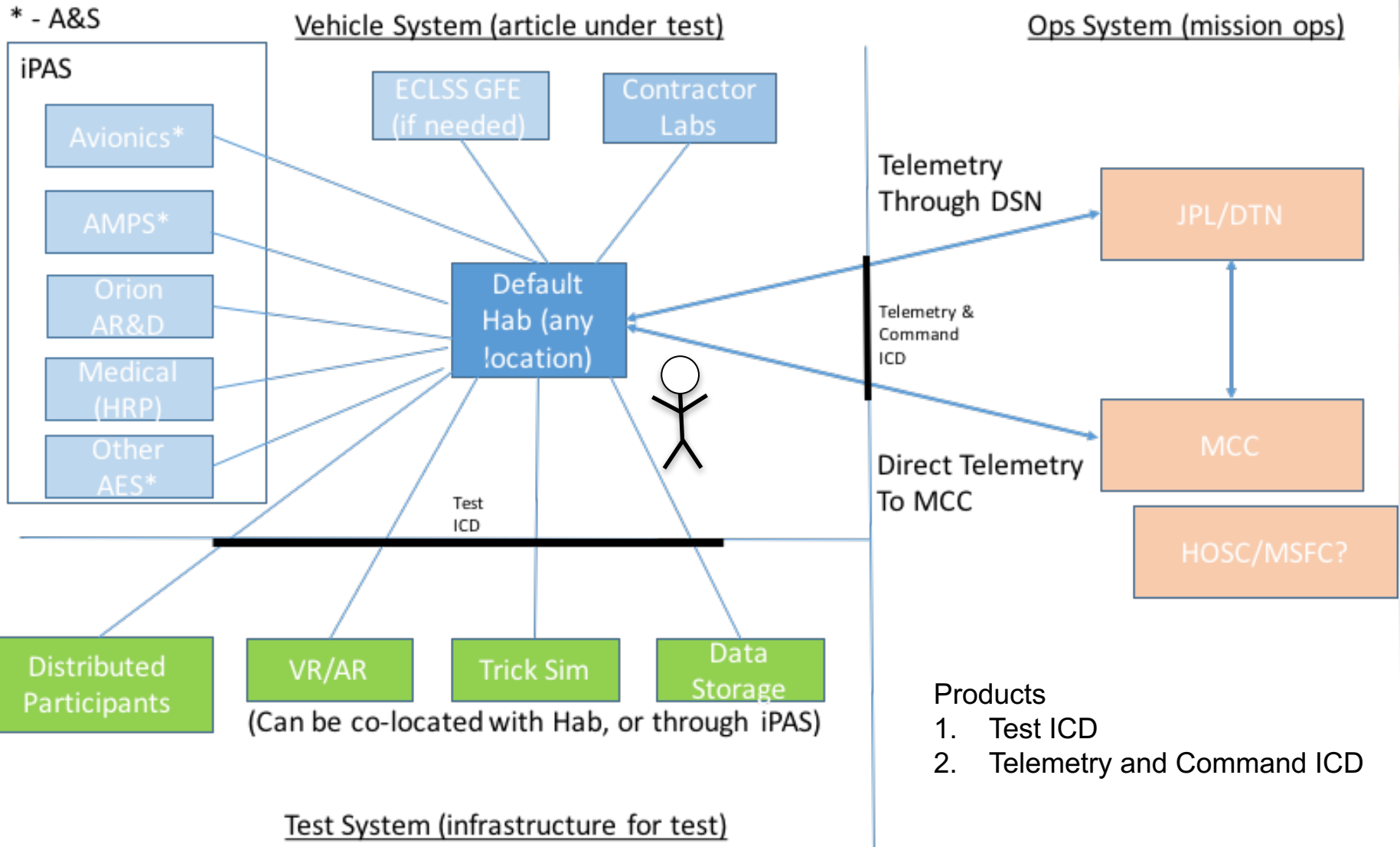
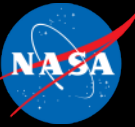
NextSTEP Ground Test



- Focus for FY17
 - Engage Stakeholders and Subject Matter Experts
 - “Break the Silos”
 - Develop and practice methodology for test
 - Includes managing Requirements, Test Objectives, Execution Plan
 - Develop and mature capability for integration and test
 - Ground Test Services: Architecture, Simulation, Visualization
 - Environments: iPAS “Flat Hab” and B9 Habitat Modules
 - If possible, derive value from tests (but not biggest thing this year)

Train the Testers and
Prepare the Infrastructure

Test Architecture



Ground Test Methodology – Top Down



HEOMD Objectives



- The National Space Policy of the United States of America directs that the Administrator of NASA shall:
 - Set far-reaching exploration milestones. By 2025, begin crewed missions beyond the Moon, including sending humans to an asteroid. By the mid-2030s, send humans to orbit Mars and return them safely to Earth.
- The NASA Authorization Act of 2010 establishes the following as a matter of national policy:
 - A long term objective for human exploration of space should be the eventual international exploration of Mars.
- The 2014 NASA Strategic Plan codifies this national policy as Agency policy under Strategic Goal 1:
 - Strategic Goal 1: Expand the frontiers of knowledge, capability, and opportunity in space.
- In support of this Agency Strategic Goal 1, HEOMD is responsible for three Objectives that are relevant to the establishment of the Exploration Objectives:
 - **Objective 1.1: Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.**
 - Objective 1.2: Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity.
 - Objective 1.3: Facilitate and utilize U.S. commercial capabilities to deliver crew and cargo to space.



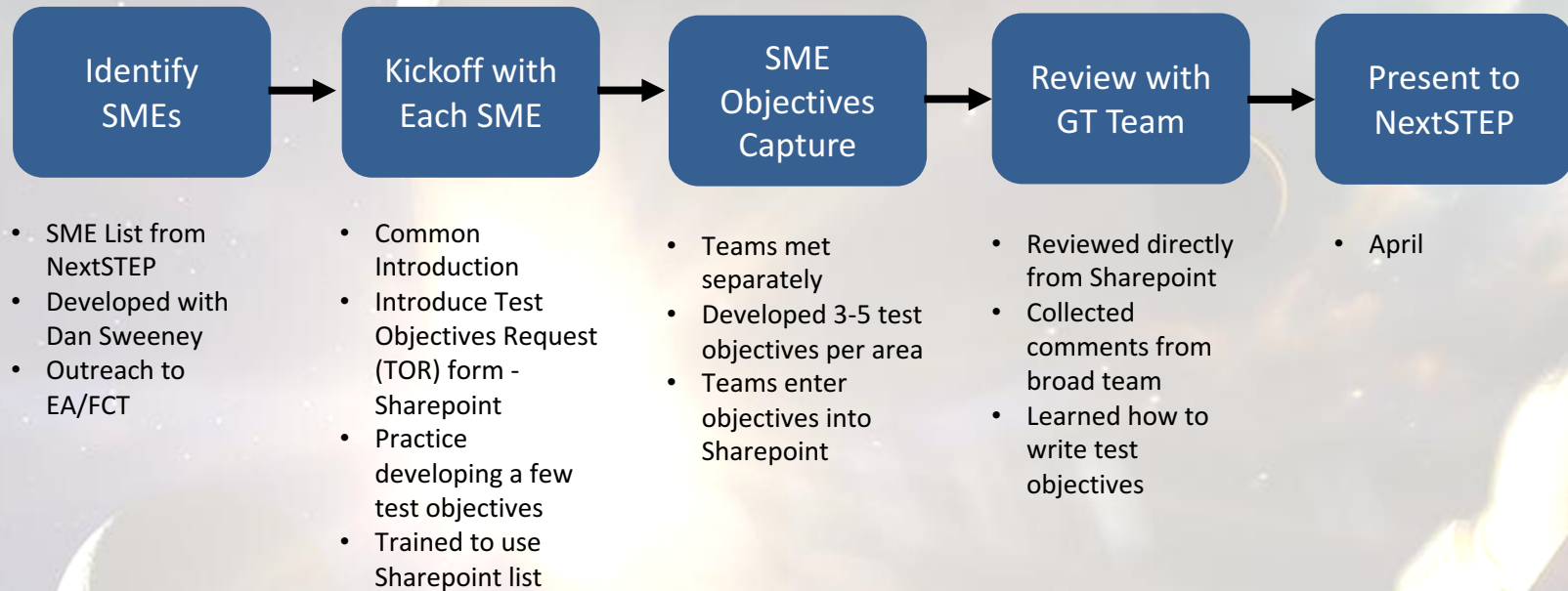
HEOMD-001
INITIAL RELEASE

RELEASE DATE: 09/07/2016

HUMAN EXPLORATION AND OPERATIONS EXPLORATION OBJECTIVES

*Publicly available: Release to Public Websites Requires Approval of
Chief, Office of Primary Responsibility*

Ground Test Methodology – Bottoms Up



Identify meaningful and achievable objectives for Ground Test.

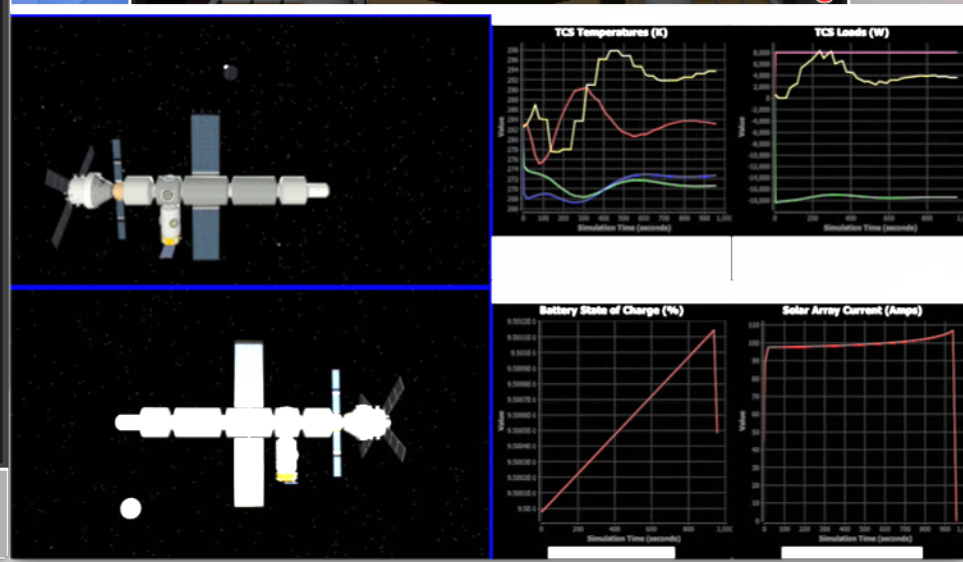
Test Objectives from SMEs



Group	Domain
GFE	ECLSS
GFE	Exercise
GFE	Radiation
GFE	SoftGoods
GFE	Windows
AES	Avionics & Software
AES	Power
AES	Autonomy
AES	Comm/ DTN
AES	Logistics
AES	Advanced EMU/ EVA
HRP	ExMC
HRP	Human Factors & Habitability
Domain	Propulsion
Domain	GNC
Domain	Structures
Domain	Active Thermal Control
Domain	EVA
Domain	MCC/Ops
Domain	Safety & MA
Domain	Robotics
Domain	Science

- Identified SMEs per category
- Consider test objectives
- Focus on what is achievable through Ground Test
 - VR
 - Simulation
 - Hardware Test

Simulation – Dr. Zack Crues

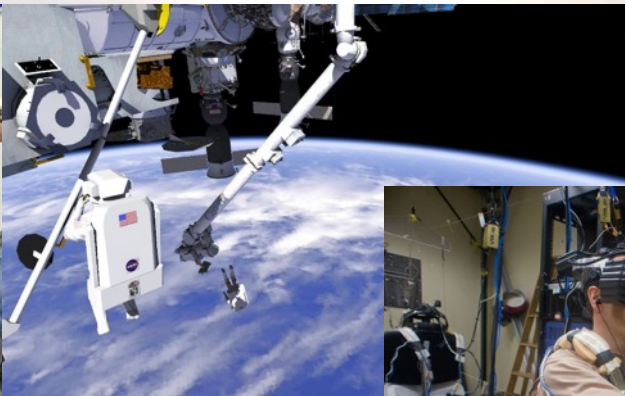


Visualization – Eddie Paddock

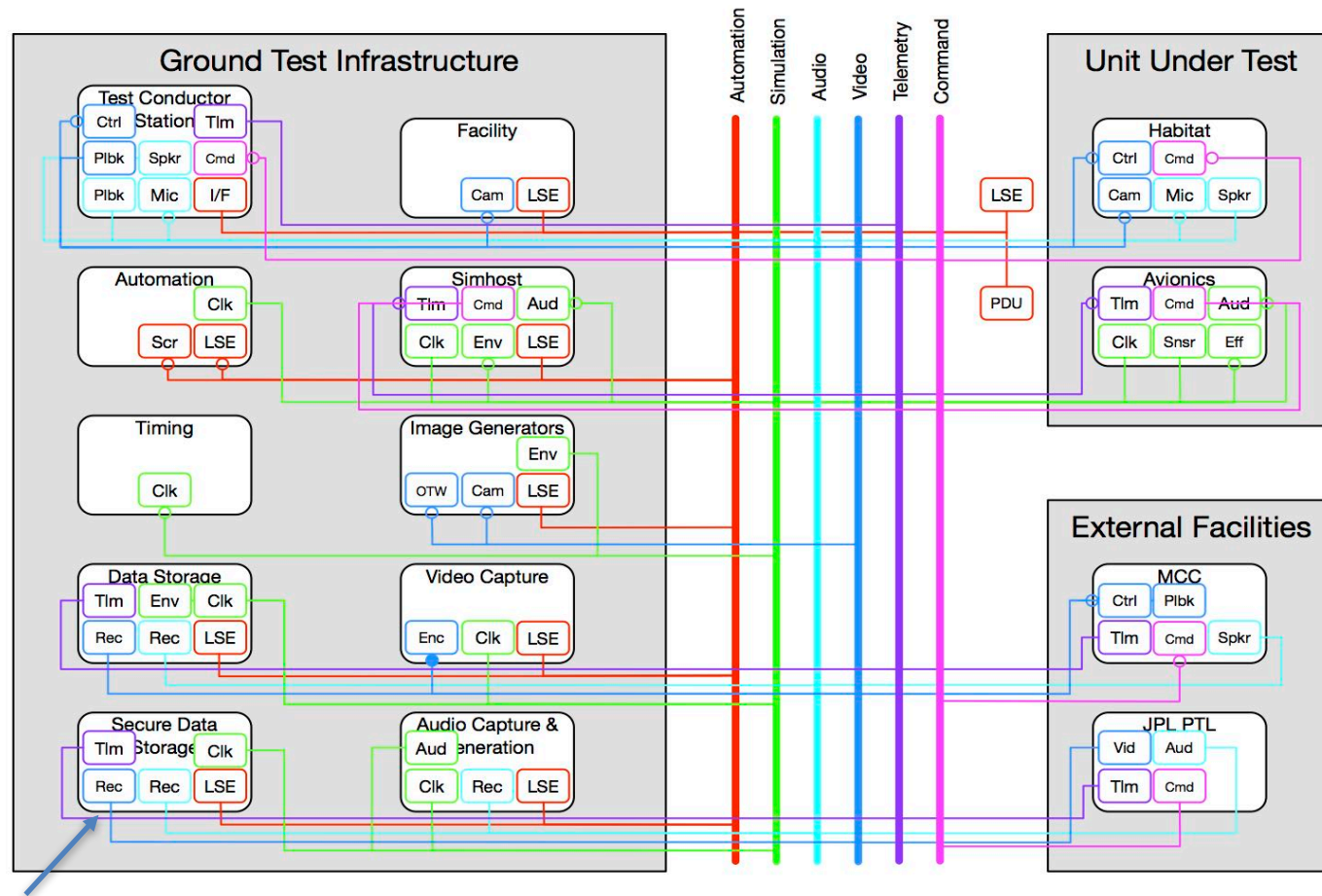


- Methodology

- Establish Data Format requirements for contractor deliverables
- Receive CAD and other data for habitats
- Integrate data into NASA VR environments
- Learn to evaluate designs using VR

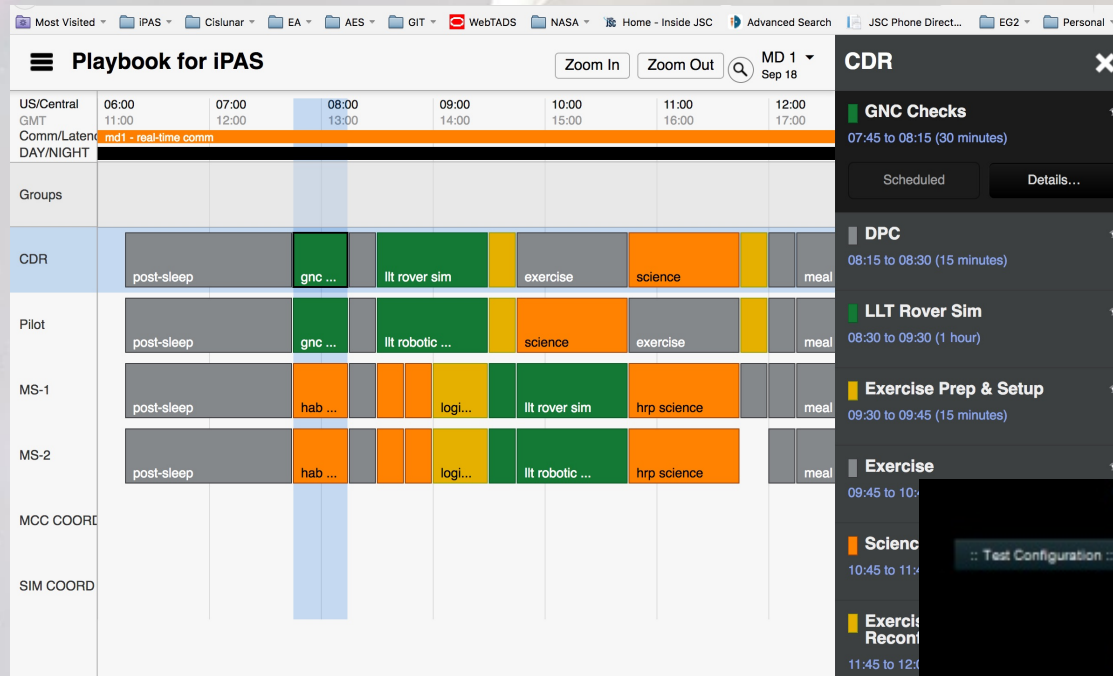


Test Architecture – Paul Bielski

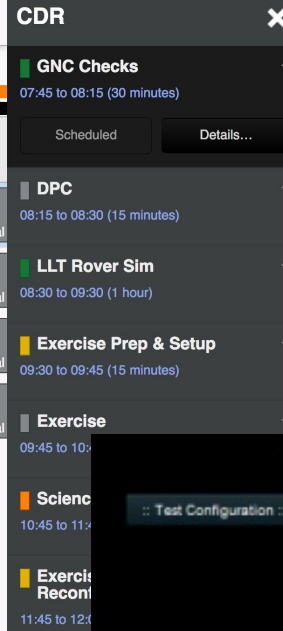


Medical Data
Proprietary Data

Test Execution



Crew Procedures : Playbook



Test Flow and Data Manager (TFDM)

:: Test Configuration ::
:: Test Run ::
:: Test Specific Panel ::
:: Test Live Plotting ::
:: Test Output Data ::

Test Configuration TC-2000 (Emotive Test Configuration)

Edit Current Test Configuration

Load Another Test Configuration

Name	Address	Port	Status
edge LTEs			
EDGE Docking LTE			
emotiv LTEs			
Emotiv Headset LTE			
ste LTEs			
Standalone Test Exec (STE)	192.168.0.2	8001	
tfdm LTEs			
Test Flow Data Manager (TFDM)	192.168.0.106	8000	
trick LTEs			
Docking Simulation LTE	192.168.0.106	8081	

Test Procedures : mREST

Mission Operations



MPCV Hardware / Software
iPAS Lab, JSC Bldg. 29

Command



DSN Operations Center
JPL Protocol Test Lab

Telemetry

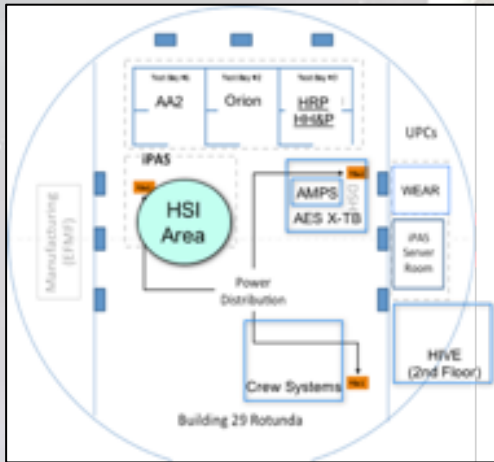


JPL

OTF, JSC Bldg. 30

Multi-Control-Center iPAS Overview

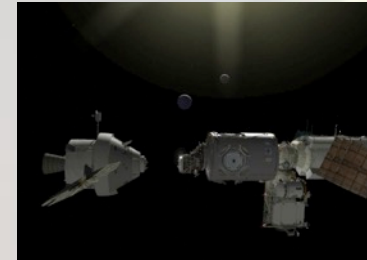
iPAS – Technology Integration and Test



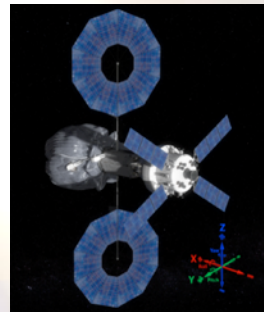
JSC, Building 29



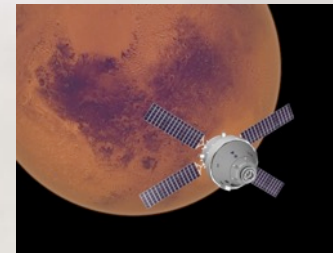
Asteroid Encounter
(2011)



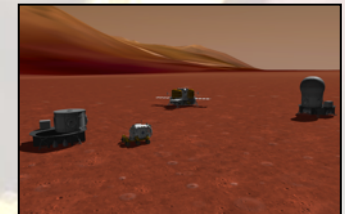
Waypoint Gateway
(2012)



Asteroid Redirect
(2013)



Phobos Orbit
(2014)



Mars Surface
(2015)

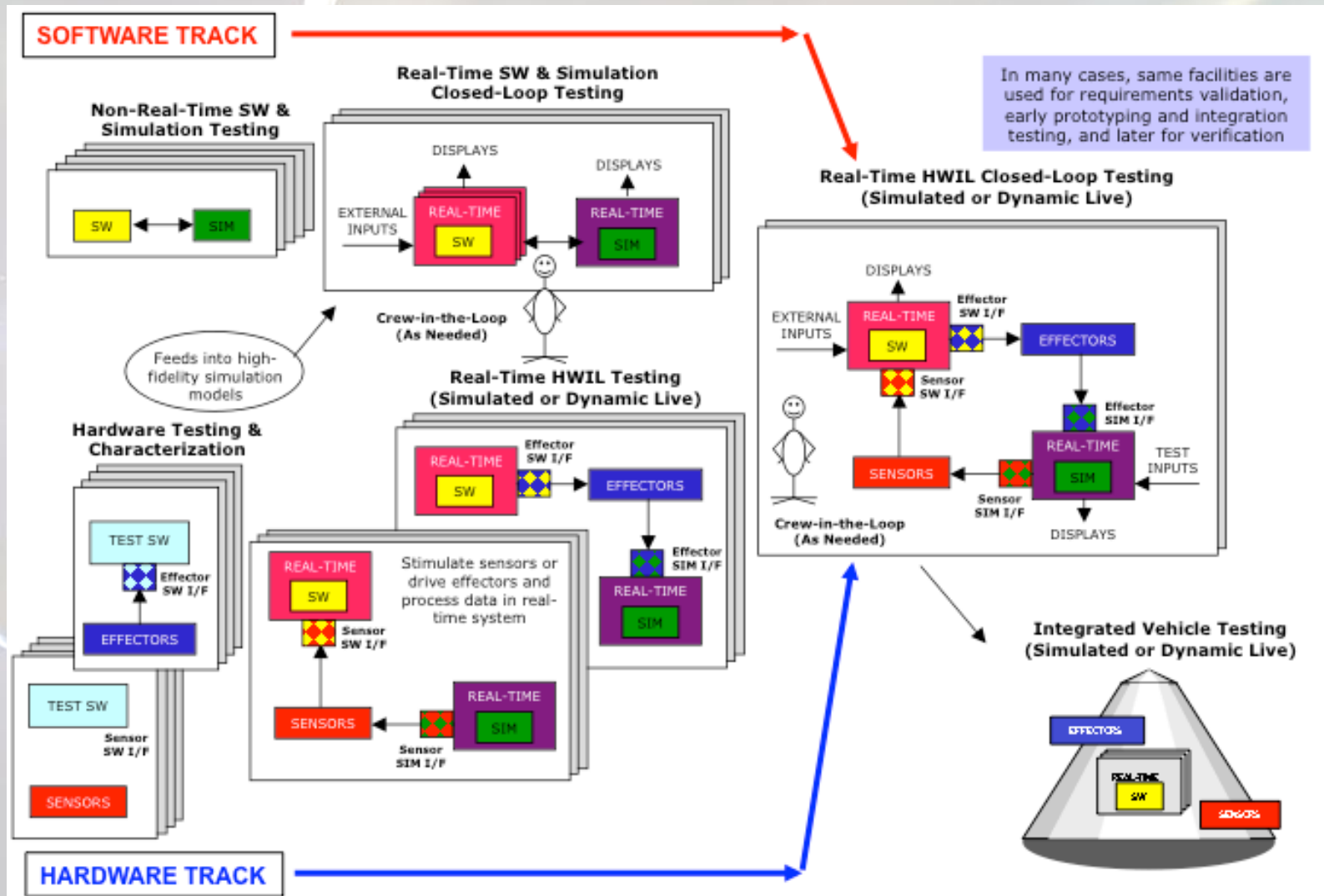


Distributed Data Network

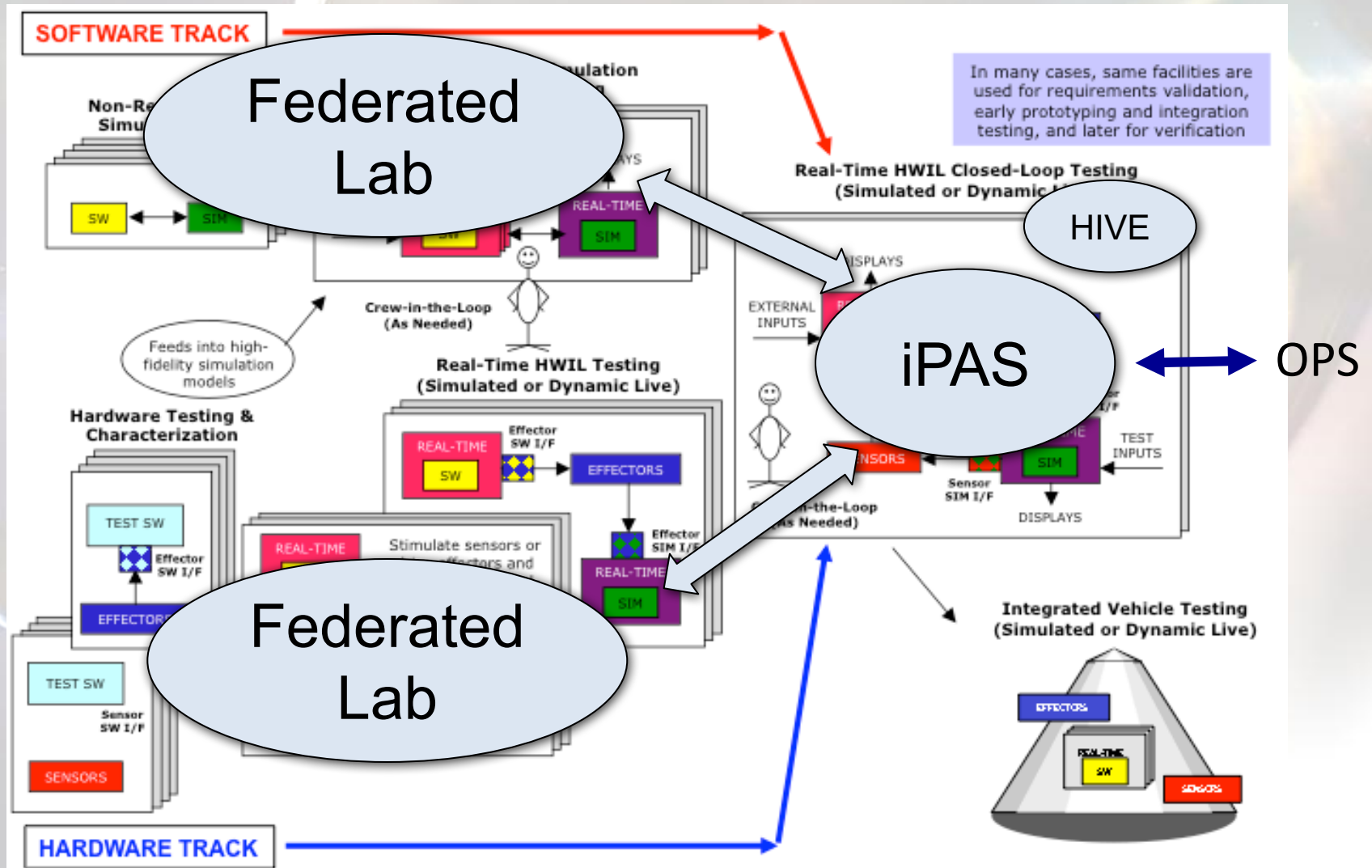


AA2 HSI Testing
(2016)

Research & Technology Development



Research & Technology Development



Co-location When Feasible



Avionics

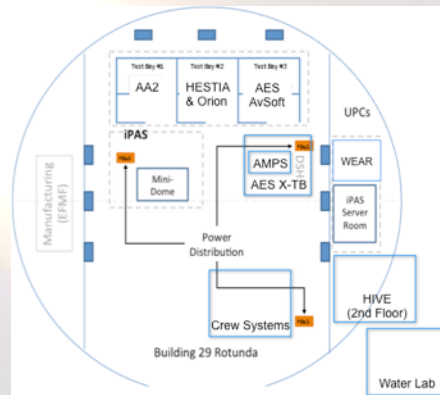
- Processors
- Networks
- Wireless
- Comm

GN&C

- ALHAT
- Crew Piloting
- On-board Trajectory Planning

Core Flight SW

- Framework
- Apps Store
- GNC Apps
- Hardware Apps



Delay Tolerant Net

- Mission Evaluation
- DTN on Radio
- DTN on Computer

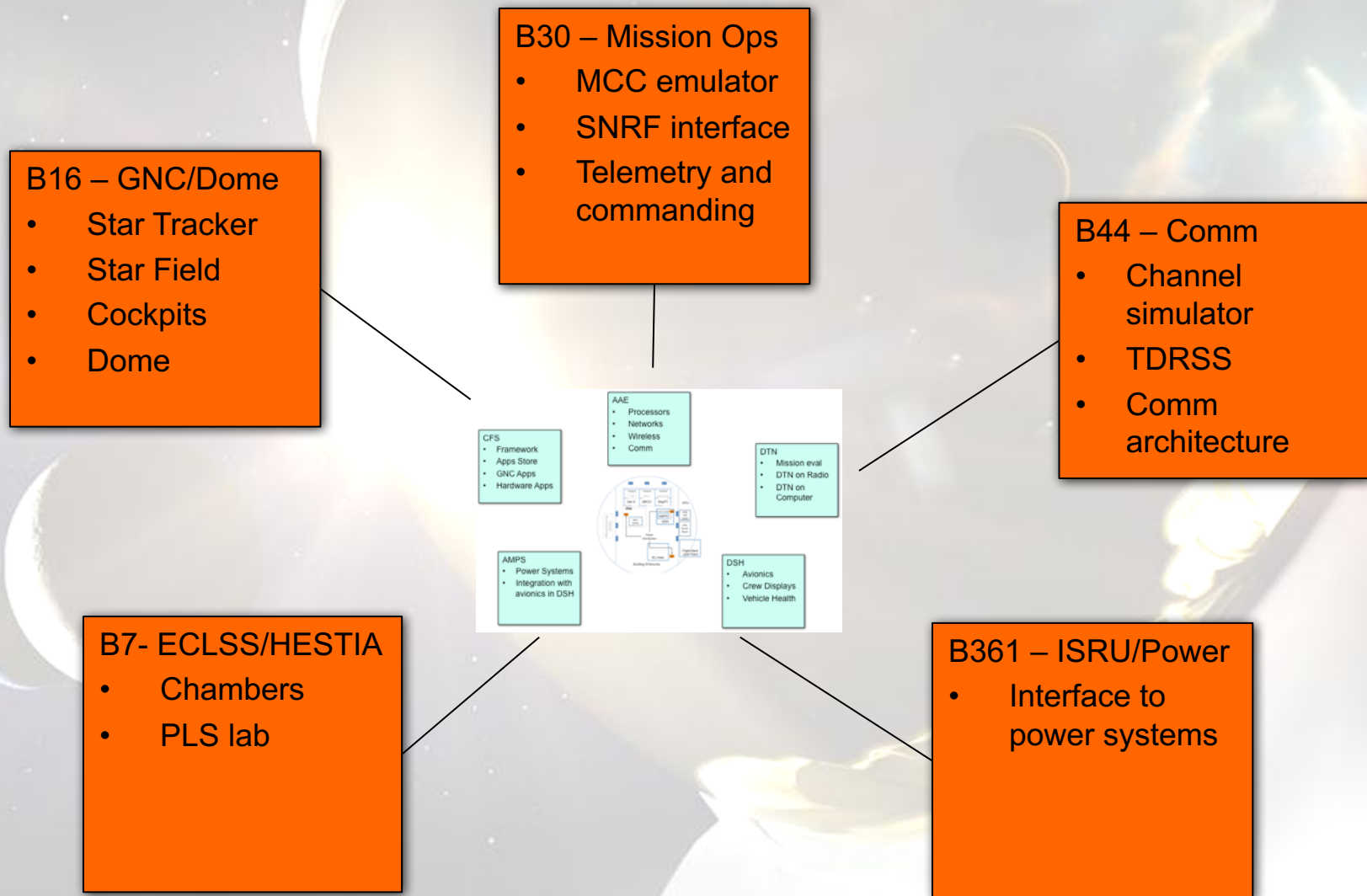
Advanced Modular Power

- Power Systems
- Integration with avionics in DSH

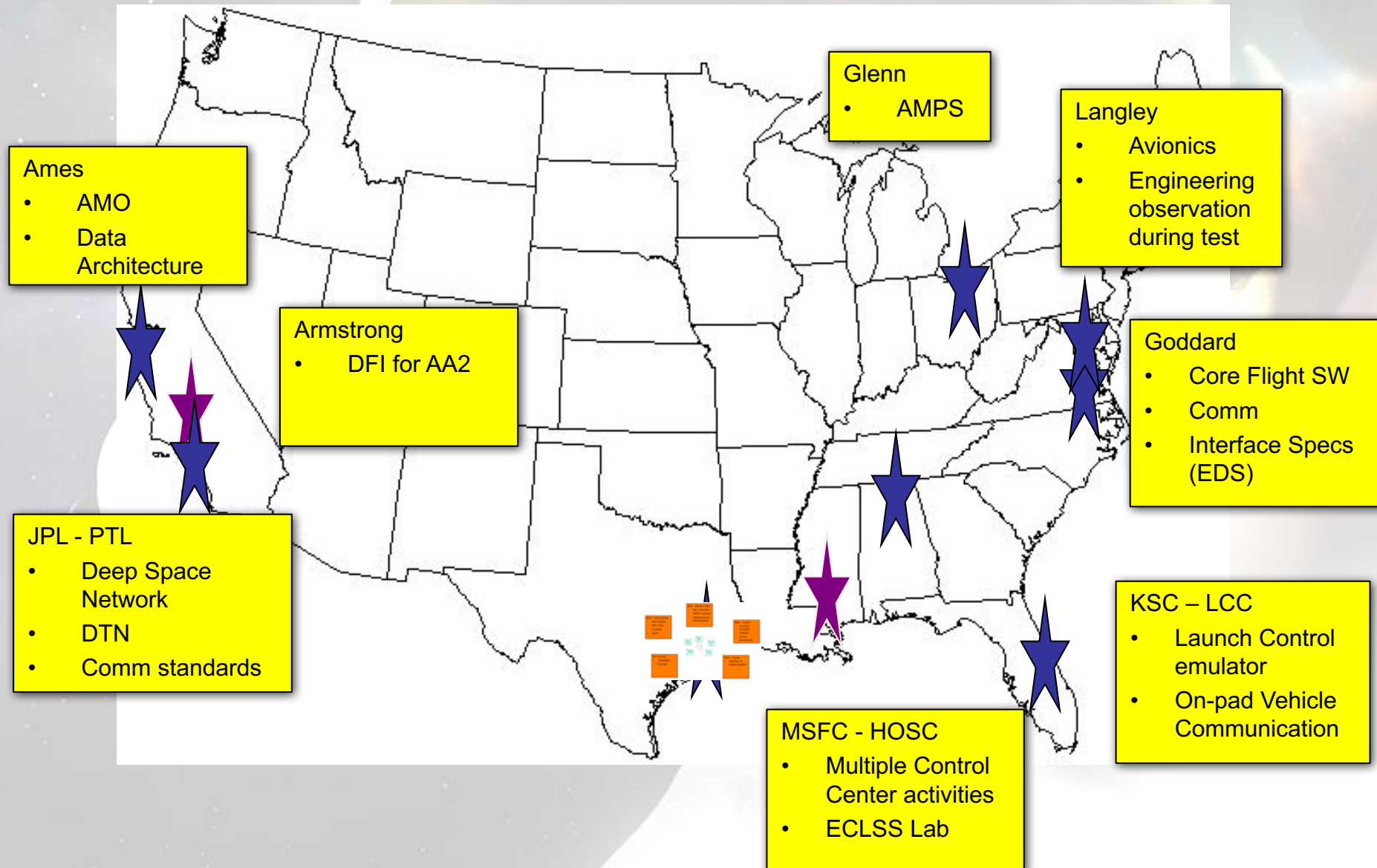
Habitat/HSI

- Exercise
- Medical
- Crew Displays
- Autonomy

JSC Lab Integration via Fiber



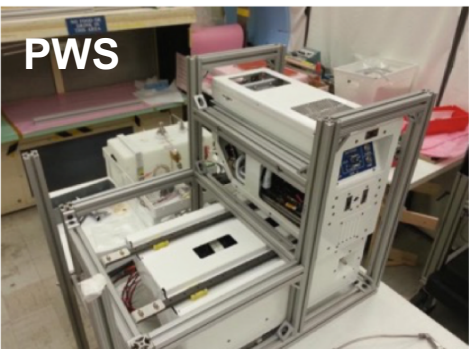
Multi-center Integration



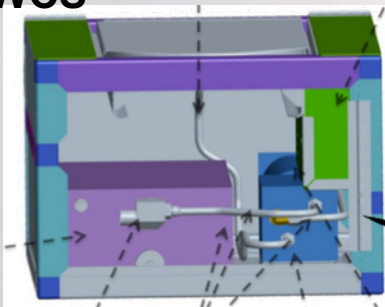
Summary of Node / Airlock Test Unit – Building 9



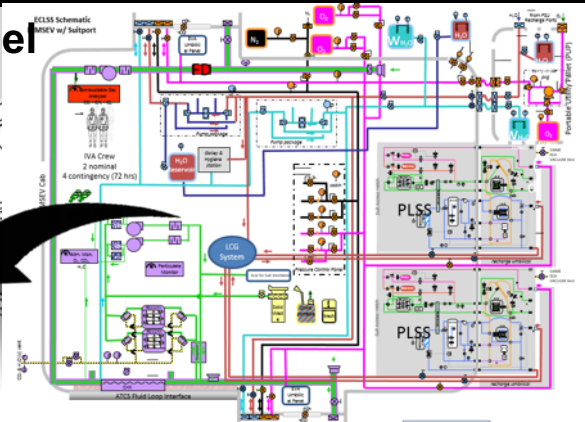
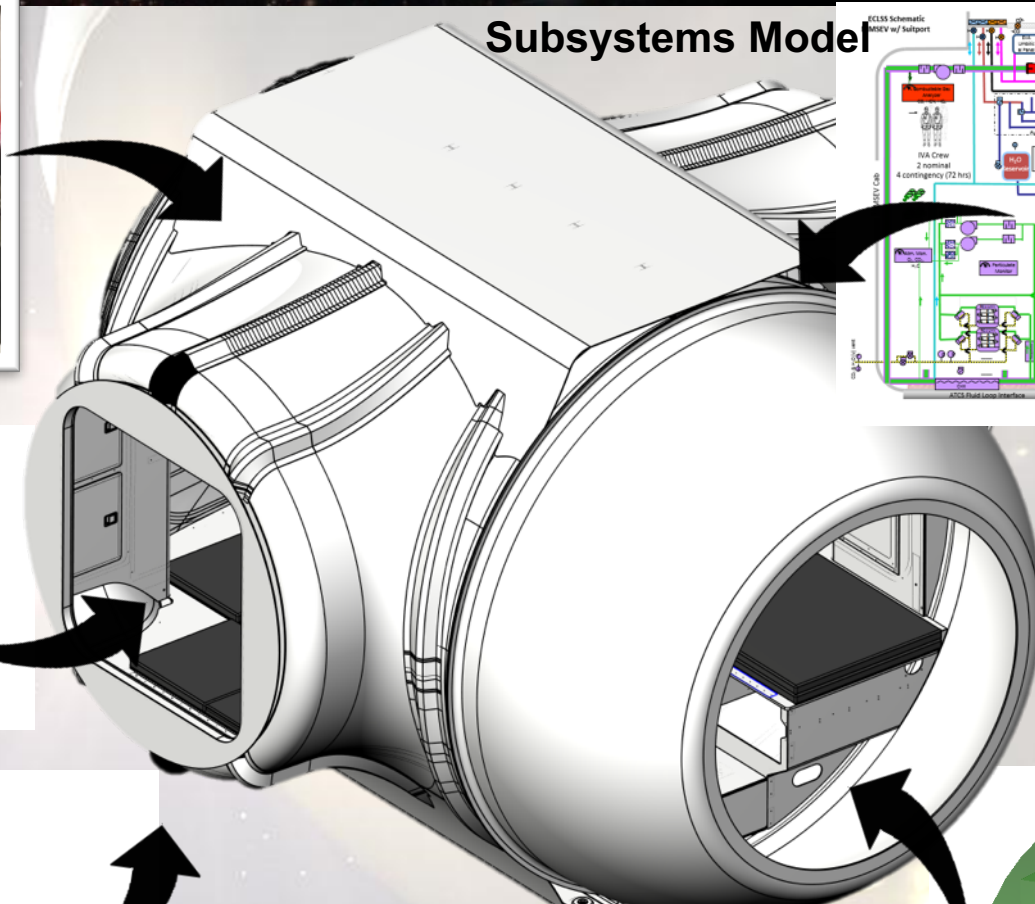
PWS



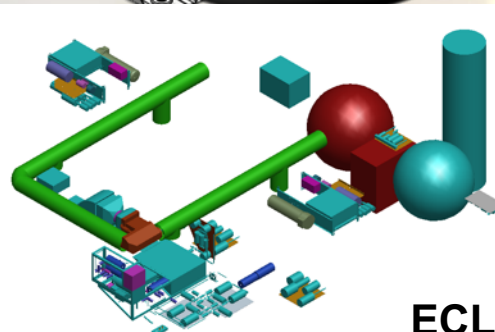
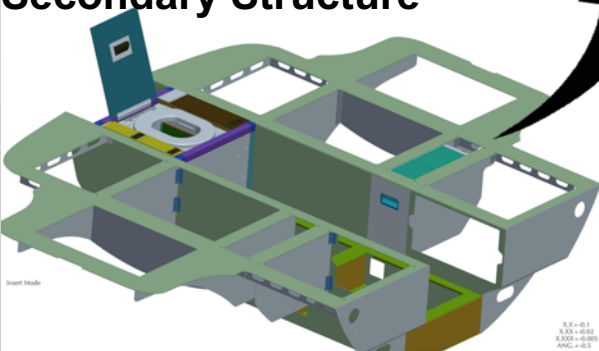
WCS



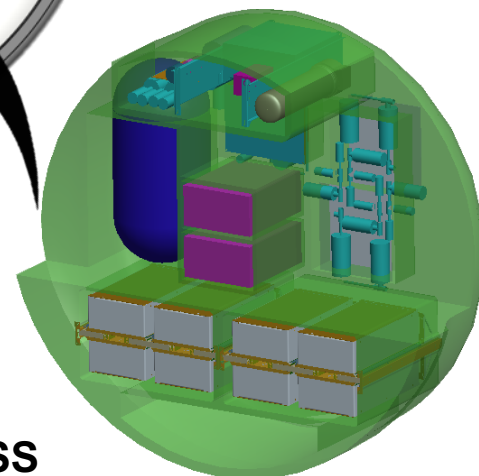
Subsystems Model



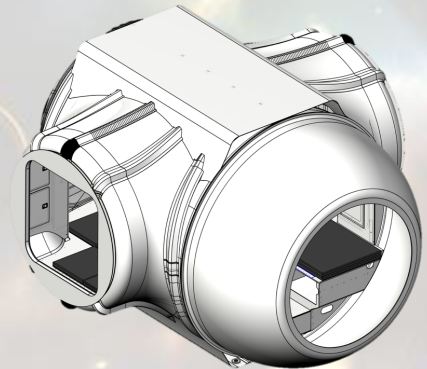
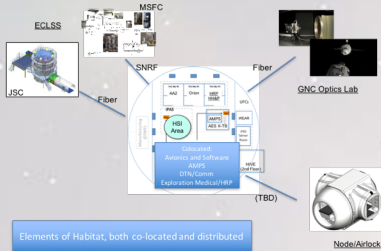
Secondary Structure



ECLSS



Integration and Test Environment



PET (hr:min)	CDR	Pilot	MS 1	MS 2		
0:30	Rendezvous and Docking		Systems Monitoring			
1:00	GNC Activation and Checkout		Systems Activation and Checkout			
1:30	Logistics Transfer		Inventory			
2:00	Exercise Device Deployment		WCS and Galley Activation			
2:30	Experiment 1 Activation		Experiment 2 Activation			
3:00	Configuration Specific Tests and Evaluations 1					
3:30	LLT Mobility Simulation		Subsystems Monitoring and Operation			
4:00	Exercise	Daily Housekeeping			LLT Mobility Simulation	
4:30	WCS				PAO	
5:00	PAO				Exercise	
5:30	Subsystems Monitoring and Operation	Exercise			WCS	
6:00		WCS			Exercise	
6:30					WCS	
7:00					IFM	
7:30	Systems Malfunction Recovery	Sample maintenance				IFM
8:00						PAO
8:30				Exercise		
9:00				WCS		
9:30	Meal Prep/Eating					
10:00	Configuration Specific Tests and Evaluations 2					
10:30	Configuration Specific Tests and Evaluations 3		Configuration Specific Tests and Evaluations 4			
11:00			Systems Malfunction Recovery			
11:30	Configuration Specific Tests and Evaluations 4		Configuration Specific Tests and Evaluations 3			
12:00						
12:30	Configuration Specific Tests and Evaluations 5					
13:00						
13:30						
14:00	Configuration Specific Tests and Evaluations 5					
14:30	Pre Sleep Ops					
15:00	Sleep					
15:30						
16:00						
23:30						
0:30					Post-Sleep	



Ultimately, functions supplied by Next Step Contractor Mockups



Test Schedule

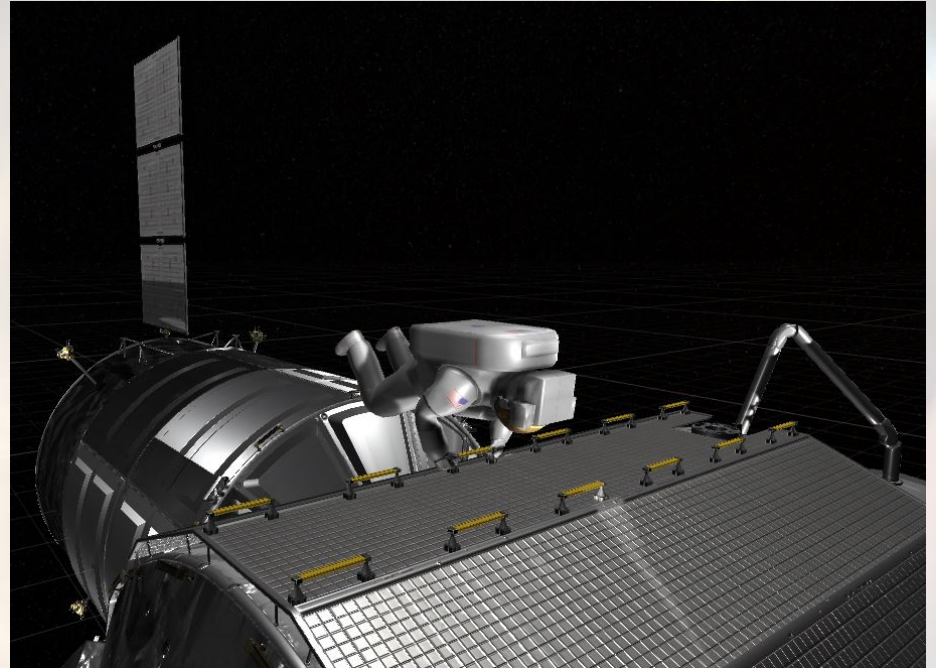


- Initial iPAS Test: September 2017
 - Completed
- Crew in the loop Test: December 2017
- Follow on habitat tests: Spring/Summer 2018
- Initial Contractor Hab tests: 1Q FY19
- In Addition: Contractors will be providing status and data during FY18, providing data such as VR models, etc.

EVA Considerations



Virtual Reality



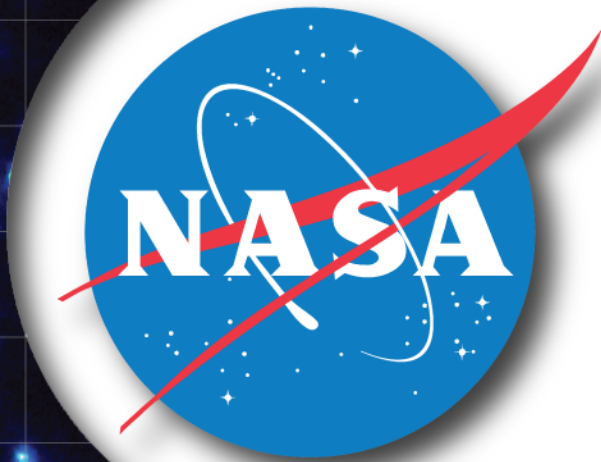
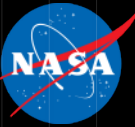
- Design Evaluation
- Mission Planning
- Crew Training
- Just in Time Training On-board

System Design and Interfaces



- Some NextSTEP Contractors may include airlock
- Design considerations
 - Stowage
 - EVA Operations
 - Integration with ECLSS
- Eventual Ground Test Plan
 - ECLSS Chambers
 - NBL

Consider what tests can be conducted on the ground, and when



BACK UP

